probe polarization, a sample holder holding a sample which has a sample polarization at a sample polarization frequency, and a mechanical oscillator engaged to one of said probe and said sample holder to move in response to an interaction between said probe polarization and said sample polarization, wherein said probe polarization frequency and said sample polarization frequency are different from each other by an amount within a frequency response range of said mechanical oscillator;

Q4 Cont.

a detection module to measure a response of said mechanical oscillator to produce a signal indicative of a property of the sample.

Q5

4. The system as in claim 1, wherein said probe module produces a probe excitation radiation wave at said probe polarization frequency to effectuate said probe excitation field and a sample excitation wave at said sample polarization frequency, wherein said sample is responsive to said sample excitation wave to produce said sample.

Q6

6. The system as in claim 1, wherein said amount is equal to or near a fundamental resonant frequency of said mechanical oscillator.

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7. The system as in claim 1, wherein said amount is equal to or near a harmonic frequency of said mechanical oscillator.

8. The system as in claim 4, wherein said probe module includes a radiation source and both of said probe excitation wave and said sample excitation wave are originated from a common wave generated from said radiation source.

Q6

~~10. The system as in claim 8, wherein an output of said radiation source is modulated at a modulation frequency to produce one of said probe excitation wave and said sample excitation wave.~~

Q7

~~12. The system as in claim 10, wherein an amplitude of the output is modulated.~~

Q8

~~13. The system as in claim 10, wherein a polarization of the output is modulated.~~

17. The system as in claim 1, wherein said probe is spaced from the sample by less than one wavelength of radiation from the probe excitation field.

Q9

18. The system as in claim 1, wherein said mechanical oscillator has a dimension less than one wavelength of radiation from the probe excitation field.

19. The system as in claim 4, wherein said mechanical oscillator has a dimension greater than one wavelength of radiation from the probe excitation radiation wave and wherein the inverse of a wavevector difference of said probe excitation radiation and sample excitation waves is less than the inverse of a dimension of said mechanical oscillator.

Q 9

Cont

20. A system, comprising:

a radiation source to produce at least a probe excitation wave at a probe frequency and another excitation wave at a frequency different from said probe frequency but coherent with said probe excitation wave to produce an interference field;

a probe having an array of mechanical oscillators to receive said probe excitation wave and said interference field, each mechanical oscillator responsive to said probe excitation wave to produce a probe polarization and said array of mechanical oscillators responsive to said interference field to produce polarizations representative of said interference field;

a sample holder to hold a sample with a sample polarization in a proximity of said probe to expose the sample to fields produced by said probe polarizations so as to cause motion of said mechanical oscillators from interaction between the probe polarization and the sample polarization; and

Q9 Con'd

a detector module to measure movements of said mechanical oscillators.

23. The system as in claim 22, wherein said mechanical oscillators are turned on and off individually according to a Hadamard matrix.

Q10

28. A method, comprising:

producing a probe polarization by exposing a probe formed of a polarizable material to a probe excitation field of a probe radiation wave at a probe frequency;

Q11

using a sample radiation wave at a sample frequency different from said probe frequency to interact with a sample and to produce a sample polarization, wherein the sample radiation wave and the probe radiation wave are coherent to each other;

placing said sample with said sample polarization in a field of said probe polarization to effectuate an interaction between the probe and the sample;

engaging a mechanical oscillator to at least one of said probe and said sample, wherein said mechanical oscillator moves in response to said interaction, wherein the difference between said probe frequency and said sample frequency is equal to or near a resonance frequency of said mechanical oscillator; and

Q 11 Con'd

detecting motion of said mechanical oscillator to measure a property of said sample.

32. The method as in claim 28, wherein the difference between said probe frequency and said sample frequency is equal to or near a harmonic frequency of a resonance frequency of said mechanical oscillator.

Q 12

34. The method as in claim 28, further comprising using another electromagnetic polarization, different from said sample polarization and said probe polarization, to affect the motion of said mechanical oscillator.

Q 13

37. The method as in claim 28, further comprising modulating a polarization or said probe frequency of said probe radiation wave.

a14

38. The method as in claim 28, wherein said probe includes a tip which is less than one wavelength of said probe radiation wave to allow evanescent coupling.

39. The method as in claim 28, further comprising:

detecting motion of said mechanical oscillator to measure a property of said sample at a first time;

detecting motion of said mechanical oscillator to measure the property at a second time; and

correlating measurements from said first and said second times to determine the property.

a15

43. The method as in claim 28, further comprising measuring the property of said sample a plurality of times when a parameter associated with excitation of said probe or sample is adjusted to have different values.

a16

50. A method, comprising:

using a probe excitation wave to illuminate an optically polarizable probe tip, the tip responsive to produce a probe polarization; and

scanning the probe tip in proximity of a sample to interact with the sample with a sample polarization and to obtain measurements of different parts of the sample from a force on said probe tip as a function of a frequency difference between frequencies of the probe polarization and the sample polarization. --

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